Swarm Music

FINAL YEAR PROJECT

Core Idea

To generate real-time music by interpreting the movement of an artificial flock of agents – or "boids" (Reynolds, 1987) – in at least 3 dimensions (pitch, dynamic, and interval between notes). Minimal music theory or other meddling will be programmed in order to produce as close to a natural interpretation of the flock as possible, hence the result is not expected to appear structured in the conventional sense, but

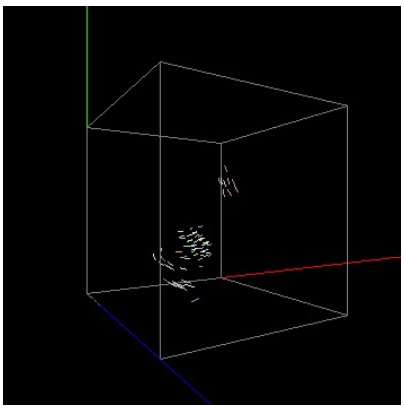

Figure 1 - A very basic boids program in Python with OpenGL

perhaps more like the work of Butch Morris (Conduction US, 2011) or meditative ambient noise.

When researching this topic, Dr Tim Blackwell of Goldsmiths, University of London was frequently the top and/or only relevant result, and as such the planning phase has been heavily influenced by his work (most of which can be found on www.timblackwell.com). For example, instead of each agent being treated as an audio source, it is the centre of mass of the entire swarm that will be interpreted as a single note, with each swarm being much smaller than Figure 1 above (perhaps fewer than ten agents per swarm), and each swarm its own instrument.

Extensions

The core system should hopefully not be terribly complicated, and though it will require more effort than simply converting coordinates into sound, I am expecting to have the core system completed by December. Current ideas for extensions (in approximately decreasing order of likelihood to be completed) are:

1) *Predators*

Add predators to the swarm to stir things up if it gets boring. Boids would avoid predators in the same way that they avoid the edge of their bounding box.

2) *Synth*

Feed MIDI-out data from program directly into a virtual instrument in order to produce higher quality audio (as default MIDI sounds leave a lot to be desired)

3) *Phrase*

Add extra dimensions (e.g. time duration of events and phrase-level control). Blackwell's extra dimensions (Blackwell & Young, 2004) are:

- Time duration of events (i.e. note length, not length of rests)
- Number of simultaneous events in a phrase
- Number of ascending or descending pitches in a phrase
- Similarity between successive phrases

4) *MIDI File Input*

Add an existing song in MIDI format to influence the swarm. This could be done by plotting the file's notes in the space and treating them as attractors for the boids.

5) *Human Input*

Add human input for real-time improvisation.
MIDI instruments would be the easiest to do this for, but with some work, microphone input of analogue instruments could be converted to MIDI.

6) *Conductor*

Allow the user to 'conduct' the music in the style of Morris (Conduction US, 2011), perhaps by allowing them to manipulate the higher-level phrase dimensions mentioned above.

Bonus

Add more interactive input method, e.g. physical sliders/Wii remotes/VR

Gantt Chart

See Figure 2 (next page).

The "Noise -> Music" activity is deliberately vague as the specifics will depend on the research and planning that is still ongoing (activity 1).

Stack

I intend to program in Python 3 using OpenGL and pygame for visualisation, and python-rtmidi for sound generation. If the synth extension is attempted, I will most likely use existing third-party software (e.g. Ableton Live, Reaper or other virtual instrument programs) than attempt to make my own from scratch.

References

Blackwell, T. & Young, M., 2004. Self-Organising Music. *Organised Sound,* Volume 9, pp. 123-136.

Conduction US, 2011. *The Composition of Conduction.* [Online]
Available at: https://www.youtube.com/watch?v=i-zx6u2XJv8
[Accessed 2017].

Reynolds, C., 1987. *Flocks, Herds, and Schools: A Distributed Behaviour Model.* [Online]
Available at: http://www.cs.toronto.edu/~dt/siggraph97-course/cwr87/
[Accessed 2017].

Swarm Music Plan

Gantt chart to plan the development of Swarm Music project

Period Highlight: 4 | Plan Duration | Actual Start | % Complete | Actual (beyond plan) | % Complete (beyond plan)

ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Basic Research	1	4	1	6	75%
Simple Boids	4	2	4	1	100%
Simple MIDI-out	5	1			0%
Link Boids-MIDI	5	2			0%
Boid Attractors	6	1			0%
Noise -> 'Music'	7	4			0%
Write Up	11	20			0%
+ Predators	11	2			0%
+ Synth	13	2			0%
+ Phrase	17	4			0%
+ MIDI File Input	21	2			0%
+ Live Human Input*	23	4			0%
+ Conduction	27	3			0%

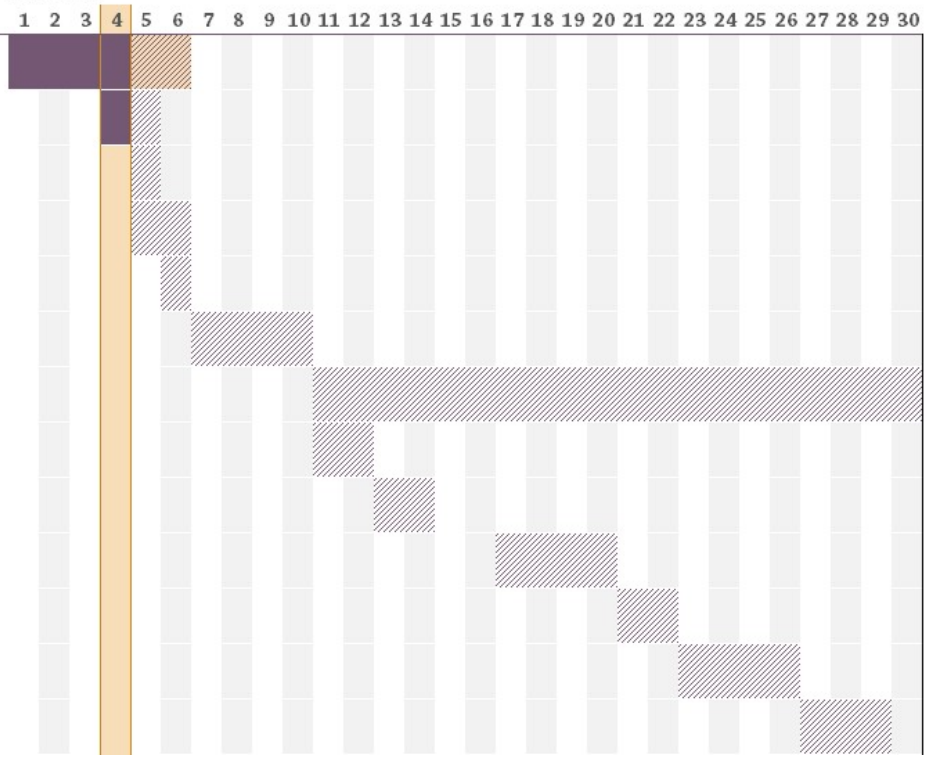

Figure 2 Gantt Chart of Project

*Though the human must necessarily have a heartbeat, the emphasis is on the input being live